

NHDOT SPR2 PROGRAM

RESEARCH PROGRESS REPORT

INSTRUCTIONS:

Project Managers and/or research project investigators should complete a progress report at least every three months during the project duration. Reports are due the 5th of the month following the end of the quarter. Please provide a project update even if no work was done during this reporting period.

Project # 26962G		Report Period Year: 2017 <input checked="" type="checkbox"/> Q1 (Jan-Mar) <input type="checkbox"/> Q2 (Apr-Jun) <input type="checkbox"/> Q3 (Jul-Sep) <input type="checkbox"/> Q4 (Oct-Dec)	
Project Title: The Living Bridge: A Benchmark for Bridge Monitoring The Living Bridge: Tidal Turbine Deployment System			
Project Investigator: Erin S. Bell Co-Project Investigators: Martin Wosnik, Kenneth Baldwin Phone: (603)862-3850 E-mail: erin.bell@unh.edu			
Research Start Date: sample July 1, 2016	Research End Date: September 30, 2018	Project schedule status: <input type="checkbox"/> On schedule <input type="checkbox"/> Ahead of schedule <input checked="" type="checkbox"/> Behind schedule	

Brief Project Description:

This project is a collaborative project between the civil and environmental engineering, mechanical and ocean engineering programs at UNH, the NHDOT and several industrial partners to install of an array of structural health monitoring, environmental and estuarine sensors on the Memorial Bridge in Portsmouth, New Hampshire that will be powered by a tidal turbine attached to one of the bridge piers. The funding for the Tidal Turbine Deployment System is leveraged with funding provided by the National Science Foundation's Partnerships for Innovation Program, The Living Bridge: The Future of Smart, Sustainable User-Centered Transportation Infrastructure.

Progress this Quarter (include meetings, installations, equipment purchases, significant progress, etc.):

Benchmark for Bridge Monitoring:

The final instrumentation plan for the structural health monitoring was discussed at the June 28th 2016 technical advisory group meeting in Concord, NH, and was approved on July 18 2016. The structural sensors were installed on the bridge structure in March 2017. The installation was complete on March 8 2017. The sensors are operational and reading data - at present to the BDI office. The integration with the local server and database is being finalized with Northeast Integration and should be complete in April 2017.

The structural model of the Memorial Bridge in SAP2000® is complete. This model is for the Portsmouth span and lift tower only. Graduate student, Timothy Nash, conducted a study of wind loads developed from AASHTO, ASCE7-10 and European codes to predict the structural response of the lift tower. Tim defended his thesis and graduated with his masters degree in December 2016. A journal paper on this work will be submitted in May 2017. This information will be compared to the measured structural response of the tower, once the data integration is completed.

A detailed model of the gusset-less truss connection in ABAQUS® is completed. The response from this model is the basis for a quantitative set of stiffness value to represent the connection in the structural SAP® model.

A set of multiscale models of the bridge and connection is under development at UNH in Lusas®. This program was chosen to mirror the modeling done during bridge design by HNTB. A comparison with the SAP® model is underway to refine the Lusas® models in preparation calibration with collected field data from the load test that will be in May 2017.

PI Bell continues to communication with bridge designer, Ted Zoli, both in live and virtual meeting. The next conference call is scheduled for April 14th 2017.

Tidal Turbine Deployment System

The design of the tidal turbine deployment system consists of vertical guide posts (VGPs) and a turbine deployment

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platform (TDP) on which the tidal turbine will be installed. The structural design of the both the VGPs and the TDP was reviewed by Duncan Mellor of Tighe and Bond, Ted Zoli of HNTB and NHDOT Bridge Design. In October 2016, UNH contracted with Pepperell Cove Marine for the installation of the vertical guide posts and the fabrication and installation of the TDP.

The VGP installation by Pepperell Cove Marine was completed by December 13th 2016.

The fabrication of the VGPs was completed by Ace Welding, Merrimack, NH. The VGPs were transported to Duncan Galvanizing and after galvanizing were transported, on March 17 2017, to the New Hampshire State Pier for assembly and loading on the Pepperell Cove Marine barge. Geno Marconi and Brent Anderson of the NH Port Authority coordinated with Geoff Tortoriello of Pepperell Cove for delivery and assembly. The pontoon were delivered from ISCO on March 1 2017. The TDP assembly began on March 21 2017. The TDP was lifted into the water and test-deployed at the bridge for one tidal cycle on March 31 2017 (spring flood tide). The TDP was then moved to the UNH Research Pier in Newcastle, NH, where it is currently moored. The installation of the estuarine instruments will take place next at the UNH Research Pier, which is a safer environment to work in for the students and researchers who are installing the instruments.

The power and communication connections from the TDP to the Memorial Bridge are under discussion and design. The energy coming from the tidal turbine will be grid-tied via an inverter and net-metered, using a separate enclosure and separate disconnect. The net-metering approach would be the simplest and most efficient/effective from an electrical connection point of view. Our turbine partners, Instream Energy Systems, have experience with these types of grid-tie inverter systems, the hardware they propose to use (Siemens SINAMICS S120 drive system) is UL 1741 certified. Our local integration partner for instrumentation, data systems and power, Northeast Integration of Portsmouth, NH, is intimately familiar with power supply and cabling on Memorial Bridge, and will design and implement the turbine electrical connection. UNH and NEI have discussed net-metering with the distributed generation manager at Eversource, the local utility. We are planning to have a contract in place with NEI by mid-April 2017.

We propose the following, in general terms: Install an inverter (electrical drive) in a separate, new enclosure on the pier cap of Pier #2, with a separate disconnect. Net-meter the electric output from the tidal turbine over the period of one year. After the project concludes and is being decommissioned, all can be taken away at once. This installation and decommissioning would not cause any disruption to the bridge grid,

UNH will meet with the NHDOT, NH Port Authority, Army Corps of Engineers and the US Coast Guard in April 2017 to discuss the operation, monitoring and removal of the tidal turbine deployment system.

PI Bell is meeting with Green Mountain Communication regarding installing a camera to monitor the TDP. Based on an April 4 2016 email from Steve Johnson, this camera will not be integrated with the NHDOT system and will be removed at the end of the project. Therefore, PI Bell is also meeting with Renee Plummer and Susan Conway to discuss using the security cameras on their buildings, which are adjacent to the bridge in stead of installed another camera.

The Living Bridge

On August 23rd, the National Science Foundation interviewed the research team from UNH and Bob Landry of NHDOT for a video profile of the Living Bridge project for Science Nation. This video was released in early November.
https://www.nsf.gov/news/special_reports/science_nation/livingbridge.jsp

Since the release of the video, several articles were written about the project, <http://www.citylab.com/tech/2016/11/living-bridge-data-smart-infrastructure-new-hampshire-memorial-bridge/508040/> and <https://www.unh.edu/unhtoday/2016/12/building-bridges>. PI Bell and Co-PI Wosnik were interviewed for Canadian Public Radio.

The Living Bridge project was presented in three separate, coordinated presentations by Co-PIs Ken Baldwin and Martin Wosnik and graduate student Ian Gagnon at the Marine Technological Society (MTS) Marine Renewable Energy Tech Surge on the topic of "Production of Renewable Ocean Energy for Small non-grid Connected Applications" on November 2-3, 2016, in Portsmouth, NH.

The project was also presented at the 2016 International Network on Offshore Renewable Energy (INORE) North American Symposium, October 29 – November 2, in Orono, ME, by graduate student Ian Gagnon.

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This project was also presented at the ASNT Annual Meeting and will be presented at the 2017 Transportation Research Board Annual Meeting, **Structural Response Monitoring of a Vertical Lift Truss Bridge** 17-06353.

A presentation on “ The Living Bridge: Tidal Energy Conversion System” was given by Martin Wosnik at the US Department of Energy/ National Renewable Energy Laboratory 3rd Marine and Hydrokinetic Technologies Instrumentation Experts Workshop on 28 February 2017 in Dania Beach, FL.

This project was presented at the Industrial Advisory Board meeting for the UNH Mechanical Engineering Department by graduate student Ian Gagnon and undergraduate senior project students on 10 March 2017.

Items needed from NHDOT (i.e., Concurrence, Sub-contract, Assignments, Samples, Testing, etc):

UNH will need access protocols for the data closet at the bridge for maintenance of the data acquisition system.

UNH will need access protocols for the TDP from both the water and the pier cap, in terms of who to contact etc.

UNH will need the NHDOT to decide on the future of the memorialbridgeproject.com website. Currently, the site is hosted at UNH and the domain name will expire in December 2017.

Anticipated research next 3 months:

Benchmark for Bridge Monitoring:

The integration of the structural health and environmental instrumentation the sensors for remote access is scheduled for completion in April 2017.

The validation of the structural models of the Memorial Bridge in Lusas® as well as local model of selected gusset-less connections at the Memorial Bridge with respect to collected data in May 2017. Calibration of the structural models for condition and performance assessment with respect to design verification. .

Tidal Turbine Deployment System

The fabrication of the turbine deployment platform frame should be in place by the end of the April 2017.

The deployment of tidal turbine deployment platform with estuarine sensors at the Memorial Bridge is planned for May 2017. The installation of the tidal turbine on the deployment platform is planned for the summer of 2017, with power and communication connection to be installed in May 2017 pending contracting with NEI.

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Circumstances affecting project: Describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope, and budget, along with recommended solutions to those problems.

As described in the “Progress this Quarter” section of this report, the schedule delay and increased cost related to the electrical conduit negatively impact this project.

Tasks (from Work Plan)	Planned % Complete	Actual % Complete
Living Bridge: Creating a Benchmark for Bridge Monitoring		
Project Coordination	100	100
Structural Model Creation	75	60
Design the instrumentation Plan	100	100
Sensor Deployment	100	85
Data Collection and Model Calibration	50	25
Incorporation of collected data and model into NHDOT protocols	0	0
Final Report and Adoption Recommendation	0	0
Tidal Turbine Deployment Structure		
Deployment Structure Design	100	100
Project Permitting	100	100
Installation of Support Posts	100	100
Procurement of the Turbine deployment barge	100	100
Site Installation	100	80
Electrical Connection	50	0
Final Report and Poster	0	0